# Water conditions and nutrient content at the artificial reef sites in Ranong Province, Thailand

by

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## 1. *INTRODUCTION*

The primary reason for installing artificial reefs (ARs) in Ranong Province was to prevent trawling and, thereby, improve catches with passive artisanal fishing gear. But artificial reefs also serve an important function of habitat rehabilitation. Some of the factors that influence this are

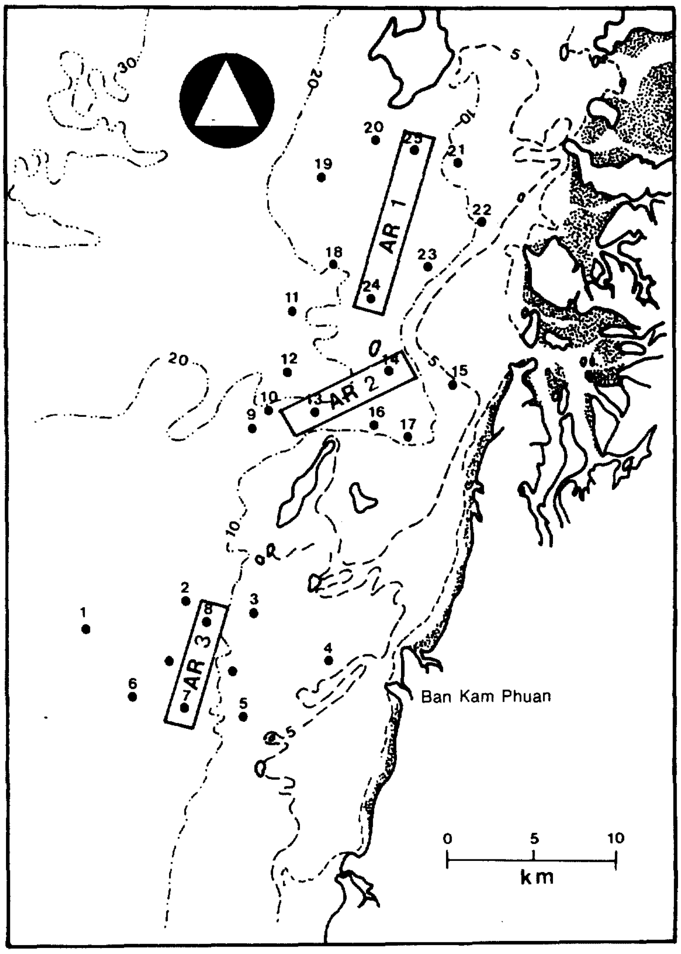
- water quality,
- nature of bottom sediment, and
- nutrient content.

As part of the biosocio—economic case study to assess the effect of installing artificial reefs, on small-scale fisheries, studies were conducted to quantify and assess environmental parameters at the AR sites.

Data was collected in December 1990, February 1992 and December 1992, during three separate cruises to the AR areas using fishery survey vessels belonging to the Andaman Sea Marine Fishery Department.

Samples were taken at 25 locations (Figure 6) to estimate total suspended solids, salinity, dissolved oxygen and other chemical parameters. Temperature and current strength! direction were also measured. In **the later cruises,** additional parameters were studied to determine the presence of inorganic nutrients **(PO4, NO3 and** NO2) and chlorophyll-a in the water column. Sediment cores were also analyzed.

**Fig 6. Map showing location and 25 environmental sampling sites at AR1, AR2 and AR3, Ranong Province, Thailand**



## 2. ***FINDINGS***

AR1 and AR2 areas showed relatively high turbidity due to dense suspended matter in the water column, particularly at ARI in December 1990 (Figure 7A-9B). It is possible that this suspended matter was a result of the run-off from the estuarine area with its mangrove vegetation.

**Fig 7 A-D. Showing areas of persistently or temporarily high content in total suspended solids. A: Distribution of depth average total suspended solids in December 1990. B: Distribution of rms values in December 1990. C: Distribution of depth average total suspended solids in February 1992. D: Distribution of rms values in February 1992**

Fig 8A-B. Distribution of depth average total suspended solids in December 1992
(A) indicates zones of high content. (B) rms values indicate zones of persistent and temporary high contents

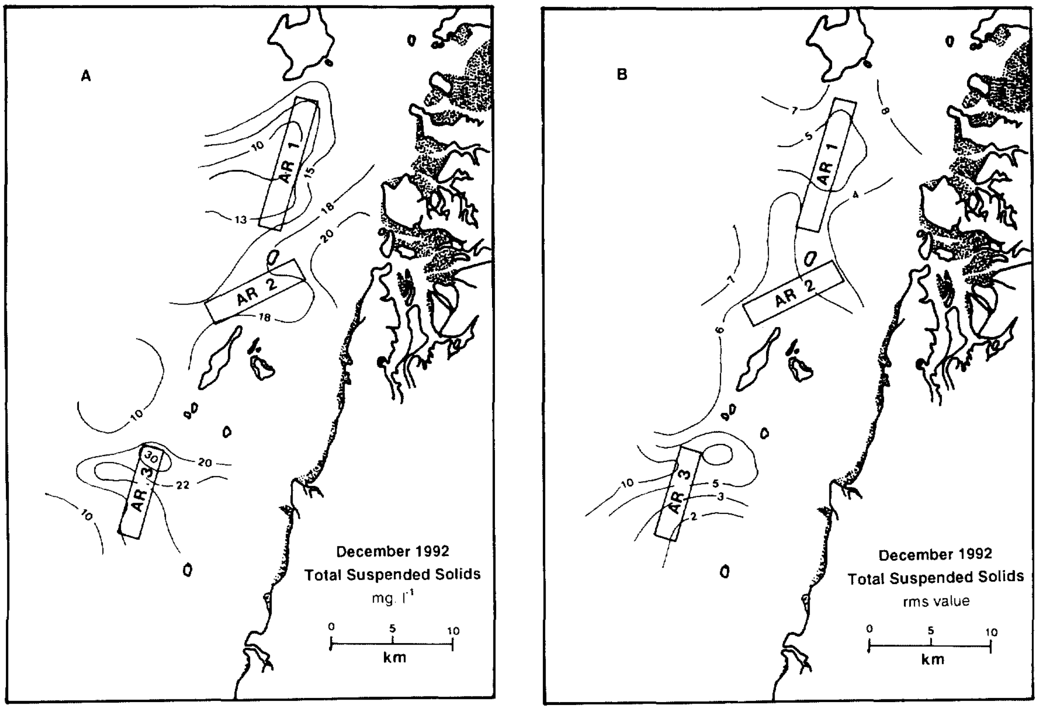
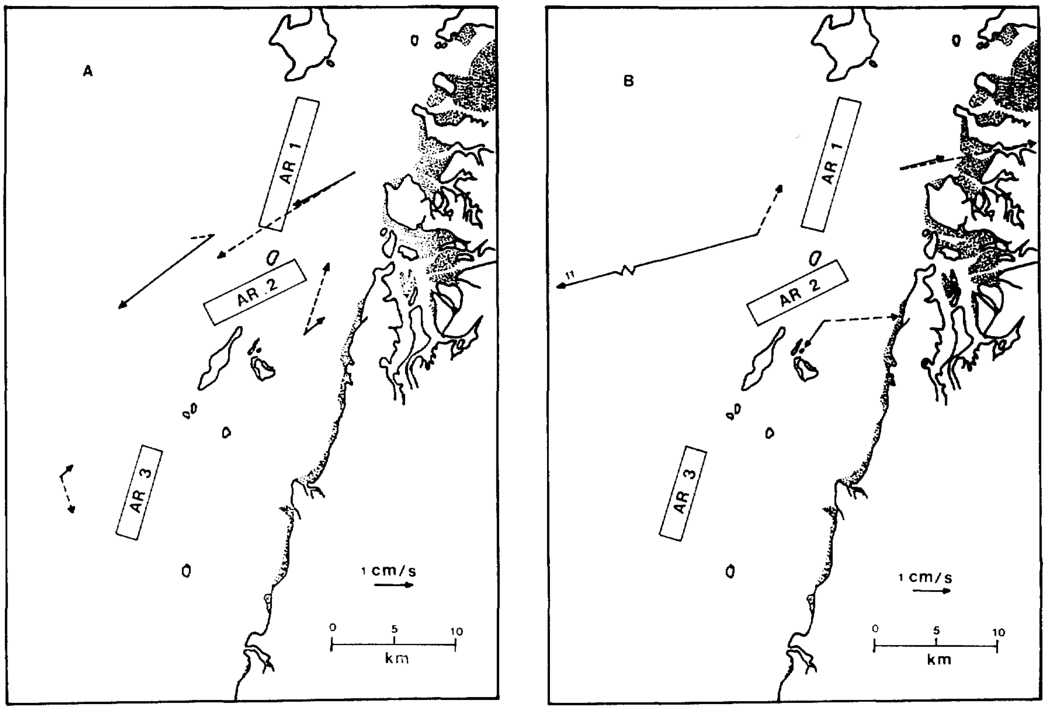


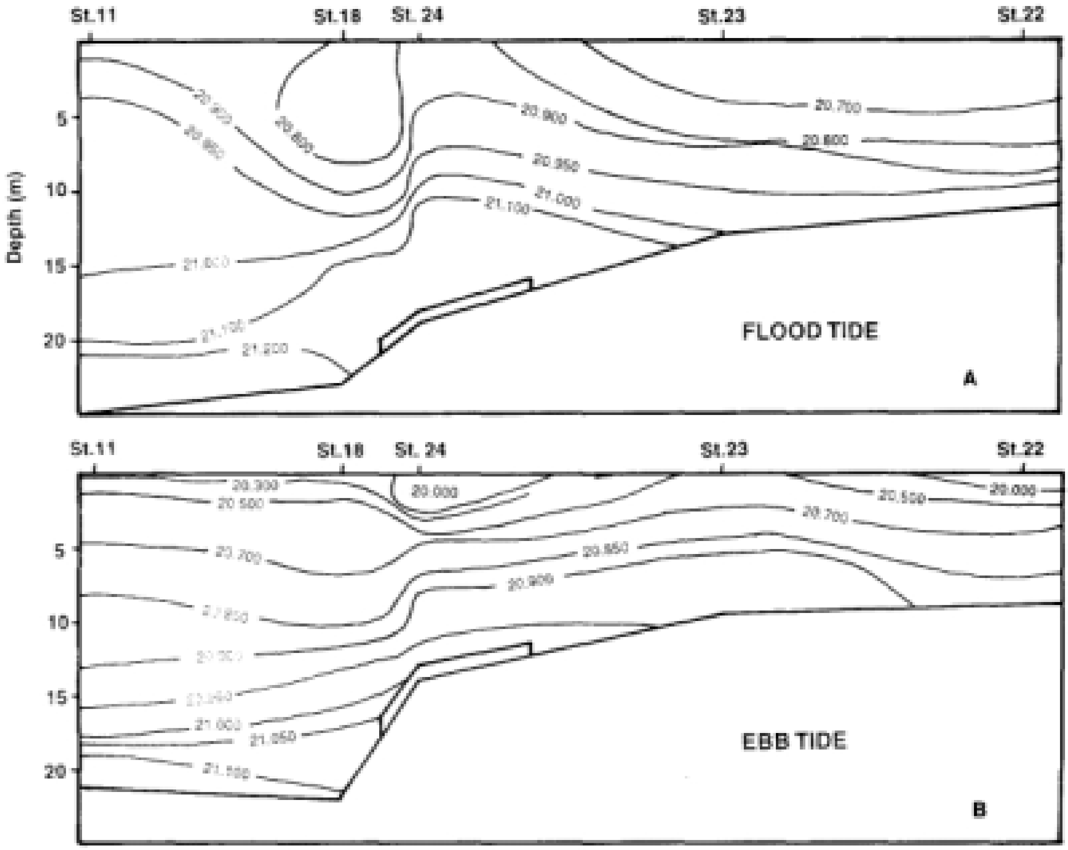

Fig 9A-B. Residual tidal current of surface flow (—>) and subsurface flow (- - - ->) are shown
(A) in February 1992, and (B) in December 1992



After continuous rainfall in December 1990 and December 1992, the total suspended solids increased at all three sites, but reduced in concentration during dry months (February 1992).

The distribution of seawater density measured over an offshore transect across AR! (Figures l0a-b) showed a definite interaction with the tides.

**Fig 10A-B. Cross section $\sigma_t$(density of seawater) distribution on an offshore transect (Stations 22, 23, 24, 18 and 11) at ARI in December 1992. (A) Zones of seawater intrusion and interaction are shown during flood tide. (B) Zones of less saline nearshore water extrusion and interaction are shown during ebb tide.**




Outflow of detritus from the mangroves, as part of the suspended matter, resulted in large amounts of dissolved inorganic nutrients (P04, NO3 and NO2) in the waters around the ARs, though the concentration varied with rainfall (Table 2).

**Table 2: Multiple range analysis (ANOVA) of each parameter of three cruises which show significant difference if the asterisk (*) locates in a different column and nonsignificant difference if the asterisk (*) is in the same column (P=0.05)**

| *Cruise no.* | *P04 ug.atm PO4/l* | | *NO3 ug-atm NO3/l* | | *NO2 ug-atm NO2/l* | | *TSS m* | | *Trans* | | *pH* | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0.656 | * | 0.130 | * | 0.063 | * | 20.08 | * | – | | – | |
| 2 | 0.115 | * | 0.489 | * | 0.031 | * | 12.41 | * | 7.06 | * | 8.05 | * |
| 3 | 0.163 | * | 0.239 | * | 0.073 | * | 16.64 | * | 8.55 | * | 8.32 | * |

**Chlorophyll-a measurements (Tables 3 and 4)** showed that, at ARI, the concentration was influenced by both seawater flushing and the run-off from the estuary, at AR2 by the run-off from the mangroves and at AR3 by seawater **intrusion alone. AR3 waters were comparatively** clear, with lower suspended solids. Relatively higher chlorophyll-a content and phaeo-pigment content occurred at AR1 and AR2. Also, the content was **more at the bottom than at the** surface (Table 4), probably due to primary benthic production. Since no significant changes in nutrients were observed at the different depths, it can be concluded that phytoplankton **were not the reason for high chlorophyll-a 1evels at the bottom.**

**The tidal surface and subsurface flows (Figures 9a-b) influenced the state of the seabed. The mean grain size of sediment at AR**1 and AR2 was 2-3 O (0.18mm), whereas at AR3 the grains were bigger. Taking the flood and ebb tides into account, a speed of 4-6 cm/sec, with relatively low residual speeds, was **common for the three AR** sites. The sandy mud **sediment of smaller grain size at AR**1 **and AR2** was comparatively easy to move and be re-suspended, thus increasing turbidity. Studies of the seabed sediments conducted in 1988 by the Marine Fishery Division also showed the same findings, leading to the conclusion that there is no significant change in the bottom sediment before and after installing ARs.

Table 3: Multiple range analysis (ANOVA) of chlorophyll-a and phaeo-pigment contents. Results show depth average of each reef indicating significant difference if asterisk (*) locates in a different column and no difference if asterisk (*) is in the same column (P = 0.05)

| ARs No. | *Chlorophyll-a* mg/m$^3$ | | *Phaeo-pigment* mg/m$^3$ | |
|---|---|---|---|---|
| 1 | 0.76 | ** | 2.37 | ** |
| 2 | 1.08 | * | 2.94 | * |
| 3 | 0.47 | * | 1.39 | * |

**Table 4: Multiple range analysis of chlorophyll-a and phaeo-pigment contents in the surface, mid-depth and bottom water. Results show elevated values of both parameters in the bottom waters** *(P<0.05;* **ANOVA, multiple range analysis) while no** significant difference in the upper layer (P>0.05; ANOVA, multiple range analysis).

| *Water layer* | *Chlorophyll-a* *mg/m3* | | *Phaeo-pigment* *mg/rn3* | |
|---|---|---|---|---|
| Sur. | 0.33 | * | 1.48 | * |
| Mid. | 0.46 | * | 1.72 | * |
| Bottom | 1.36 | * | 3.31 | * |

## 3. *CONCLUSIONS*

Environmentally, ARs 1 and 2 are located very close to mangrove and estuarine areas and, hence, prone to high turbidity. This could, perhaps, play a negative role on the sealife dwelling near them. **AR3 showed less suspended solids, particularly during the dry winter months.**

The Southwest Monsoon in the summer months brings heavy rain and heavy run-off from the mangroves and estuaries, causing considerable mixing of water. These conditions also contribute to inorganic nutrients being discharged into the sea. While AR2 has pronounced mangrove run-off, AR3 is dominated by seawater intrusion and, hence, has more marine conditions, relatively clear water and less suspended solids. Higher nutrient levels at AR1 and AR2 contribute to high chlorophyll-a content also.

The sediments around ARs 1 and 2 were fine and, generally, undisturbed by the dynamics of the water around them, but the sand and mud around AR3 were of larger sized grains and less easily unsettled. Weak turbulence in the water observed may have been due to bottom obstruction contributed by the scattered modules of the ARs, but is of little consequence.

These results indicate that the locations of ARI and AR2 did not favour colonization and aggregation of various organisms of commercial value, though nutritional enrichment of the water was evident. AR3 appeared to have environmental conditions which were more favourable for the objectives of the AR.

The presence of ARs does not seem to affect the natural environmental conditions in any significant way.